SE MECHATRONICS SEM-III Sub:- THERMODYNAMICS & HEAT TRANSFER
DT. 18/05/2017.

Q. P. Code : 726401

(Time 3 Hours) **[Total Marks : 80]**

N.B.: (1) Question No. 1 is compulsory.
(2) Attempt any THREE from question no. 2 to 6.
(3) Use illustrative diagrams wherever required.

1. Attempt **ANY FOUR** **20**

(a) State Zeroth law of thermodynamics. What is its significance?
(b) Differentiate CI and SI engines.
(c) State and explain critical thickness of insulation. How it is calculated in case of cylinders.
(d) Draw pool boiling curve for water and state different regions.
(e) What do you mean by 'effectiveness' of a heat exchanger?
(f) Define and explain degree of reaction as applied to reactions turbines.

2. (a) Explain with neat sketches **any two** of the following: **10**
(i) Stop valve, (ii) Feed check valve, (iii) Blow off cock, (iv) Fusible plug

(b) During a boiler trial following readings were noted, **10**
Feed water = 1400 kg/hr,
Temperature of water T = 140°C,
Boiler working pressure of dry and saturated steam = 20 bar,
Coal used = 200 kg/hr,
Calorific value of fuel = 28000 kJ/kg,
Cp of products of combustion = 1.028 kJ/kg K
Find
(i) Thermal efficiency
(ii) Equivalent of evaporation
(iii) Heat carried away by flue gases

3. **(a)** Derive the expression for maximum blade efficiency in Parson's reaction turbine. **10**

(b) The impulse turbine has a covering nozzle and one ring of moving blades. The nozzles are inclined at 220 to the blades whose tip angles are both 350. The velocity of steam leaving the nozzle is 660 m/s. Find (i) Blade speed and diagram efficiency assuming no friction along the turbine blades, (ii) If the relative velocity of steam to blade is reduced by 15 % due to friction, find blade efficiency and end thrust. **10**
Assume power developed= 170 kW.

TURN OVER

4. (a) Write the steady flow energy equation and apply it to: **10**
   (i) Nozzle
   (ii) Throttling device
   (iii) Turbine
   (iv) Compressor
   (b) Derive general heat conduction equation in Cartesian Co-ordinate & reduce it to all three forms. **10**

5. (a) A steady flow system receives 45 kg/min of gas at 2 bar, 90°C, with negligible velocity, and discharges it at a point 25m above the entrance section at a temperature of 300°C with a velocity of 2500 m/min. During this process 1.4 kW of heat is supplied from external source and the increase in enthalpy is 8.4 kJ/kg. Determine the power output. **08**
   (b) A gas engine working on otto cycle has a cylinder diameter 20cm and stroke of 25 cm. The clearance volume is 1570 cm^3 Find air standard efficiency. Assume C_p = 1.004 kJ/kgK and C_V = 0.717 kJ/kgK. **06**
   (c) Derive expression for LMTD for parallel flow type heat exchanger. **06**

6. (a) In a straight tube of 60 mm diameter, water is flowing at a velocity of 12 m/s. The tube surface temperature is maintained at 70°C and the flowing water is heated from the inlet temperature 15°C to an outlet temperature of 45°C. Calculate the following: **10**
   (i) The heat transfer coefficient from the tube surface to the water,
   (ii) The heat transferred, and
   (iii) The length of the tube.
   Take the physical properties of water at its mean bulk temperature of 30°C, $\rho = 995.7\ kg/m^3$, $Cp = 4.174$ kJ/kg K, $k = 61.718 \times 10^{-2}$ W/m K, $\nu = 0.805 \times 10^{-6}\ m^2/s$, Pr = 5.42,
   Use $Nu = 0.23\,(Re)^{0.8}\,(Pr)^{0.4}$
   (b) Two large parallel steel plates of emissivities 0.8 and 0.5 held at temperatures of 1000K and 500K respectively. A thin copper plate of emissivity 0.1 is introduced as a radiation shield between these two plates. Determine the radiant heat exchanger in W/m^2 between the plates. Take $\sigma = 5.67 \times 10\text{-}8\ W/m^2 K^4$. **10**

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